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KOLYMA WATER BALANCE STATION
Magadan Oblast, Northeast U.S.S.R.

United States-Soviet Scientific Exchange Visit

Charles W. Slaughter and Michael A. Bilello

May 1977

CORPS OF ENGINEERS, U.S. ARMY
COLD REGIONS RESEARCH AND ENGINEERING LABORATORY
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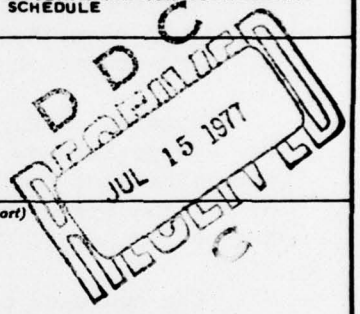

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Two U.S. scientists visited Kolyma Water Balance Station (KWBS) in Magadan Oblast of northeast U.S.S.R. during the last two weeks of August 1976. Under the auspices of the Joint U.S.A. - U.S.S.R. Agreement on Cooperation in the Field of Environmental Protection, this trip was undertaken to review current Soviet watershed hydrology research in a permafrost-dominated setting similar to that of central Alaska. Research objectives, instrumentation, and field practices were observed and discussed at KWBS. A series of proposals for future cooperation in high-latitude hydrology research and data exchange was prepared.

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PREFACE

This report was prepared by Charles W. Slaughter, Research Hydrologist, U.S. Department of Agriculture, Forest Service, Institute of Northern Forestry, Fairbanks, Alaska; and Michael A. Bilello, Meteorologist, Snow and Ice Branch, Research Division, U.S. Army Cold Regions Research and Engineering Laboratory.

Mr. Bilello's participation in the United States-Soviet Exchange Visit described in this report was funded under DA Project 4A161102AT24, *Research in Snow, Ice and Frozen Ground;* task A2, *Cold Regions Environmental Interactions;* work unit 002, *Cold Regions Environmental Factors.* Dr. Slaughter's participation in the visit was supported under the Institute of Northern Forestry multi-functional research work unit, *Ecology and Management of Taiga and Associated Environmental Systems in Interior Alaska.*

The technical review of this report was performed by Dr. L.A. Viereck, Principal Plant Ecologist, Institute of Northern Forestry, Forest Service, U.S. Department of Agriculture, Fairbanks, Alaska.

Russian to English translations of names and places were provided by Dr. George Swinzow, Geologist, CRREL. The authors wish to acknowledge the editing of the manuscript by Ms. Mona McDonald and the final typing of the manuscript by Ms. Margaret Duke, both with the Technical Information Branch, Technical Services Division, CRREL.

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United States-Soviet Scientific Exchange Visit

by

Charles W. Slaughter and Michael A. Bilello

INTRODUCTION

In August 1976, two U.S. scientists visited the Kolyma Water Balance Station, Magadan Oblast, northeastern U.S.S.R: Dr. C.W. Slaughter, Institute of Northern Forestry, U.S. Forest Service, Fairbanks, Alaska 99701; and Mr. M.A. Bilello, U.S. Army Cold Regions Research and Engineering Laboratory, Hanover, N.H. 03755. This visit was in partial implementation of U.S.A. and U.S.S.R. Environmental Agreement, subproject B-4, "Comparative Hydrologic Research in Alaska and in Magadan Oblast in Relation to Rational Utilization of Freshwater Resources." It was conducted under theme A-1 (Productivity and Functioning of Northern Ecosystems) of project V.2-1 (Protection of Northern Ecosystems), according to the Memorandum of the 4th Session of the Joint Soviet-American Commission on Cooperation in the Field of Environmental Protection, dated 3 October 1975. The exchange is in accordance with the U.S.A.-U.S.S.R. Agreement on Cooperation in the Field of Environmental Protection, signed by N.P. Podgorny and R.M. Nixon on 23 May 1972.

"Environmental planning and management require an adequate data base on water-yield under extreme and unique cold regions' hydrologic conditions. The objective of this project is to analyze existing data from two existing watersheds, one in Magadan and one in Alaska, in order to determine similarities and contrasts between these two hydrolgic settings under various landscape manipulations."*

The Kolyma Water Balance Station had been briefly visited by U.S. scientific delegations on two earlier occasions: in 1974 (Jorgenson 1974) and in 1975 (West 1976). On each visit, similarities with ongoing Alaskan watershed hydrology research were noted. Two Soviet reports on KWBS were obtained for subsequent translation in the U.S.A. (Kuznetsov et al. 1969, Kuznetsov and Nasybulin 1970). Review of these reports provided further impetus for

*Extracted from original protocol for subproject B-4.

exploring possible cooperation. Further, the timing of these exchange visits coincided with efforts to organize a program of circumpolar high-latitude hydrologic research basin activities, under the International Hydrological Decade* (Slaughter and Santeford 1975).

This visit was intended to acquaint American scientists more thoroughly with hydrologic and water balance investigations of upland permafrost terrain being conducted by personnel from the Kolyma Survey of the U.S.S.R. Hydrometeorologic Service. The U.S. scientists are currently engaged in hydrologic and climatologic research in permafrost-dominated locales of North America, and have experience in high-latitude hydrology research in Scandinavia and South America as well. Thus, this opportunity is appropriate to the broadening of U.S. efforts and to the initiation of U.S.A.-Soviet cooperation in northern hydrology.

SETTING

The Kolyma Water Balance Station (Stokovaya) is located in the mountainous headwaters of the Kolyma River System (Fig. 1). The Kolyma is one of the major north-flowing rivers of northeast U.S.S.R. and is one of the "frontier" regions of the Soviet Union. Terrain in the vicinity of Stokovaya is rugged, showing much evidence of recent (Wisconsin) glaciation. Treeline is at less than 1000 m msl. Permafrost is widespread, if not continuous, with 400 to 600 m of permanently frozen ground underlying an active layer (zone of seasonal thaw) varying from 20 to 600 cm, depending on local conditions.

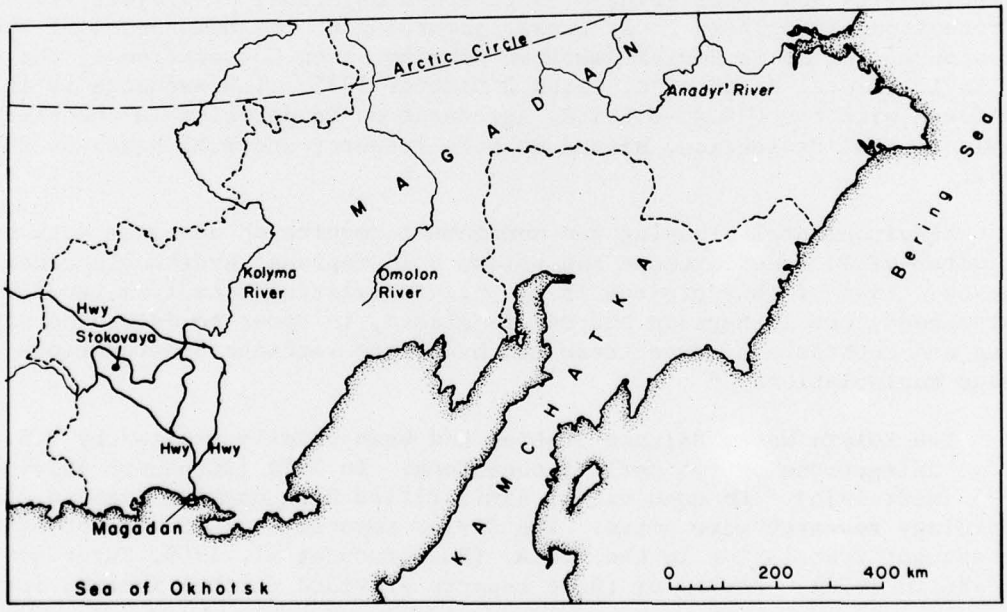


Figure 1. Magadan Oblast, U.S.S.R., and location of Kolyma Water Balance Station (Stokovaya).

*Now International Hydrological Program administered in the U.S.A. by the U.S. National Committee for Scientific Hydrology.

Figure 2. Dr. A.S. Kuznetsov, Director, Magadan Hydrometeorological Observatory, on left, and Dr. G.V. Rumyantsev, Chief, Kolyma Survey, U.S.S.R. Hydrometeorologic Service.

Vegetation is remarkably similar to that of interior Alaska in general appearance, with many of the same species appearing: Birch (*Betula pubescens*); Labrador tea (*Ledum decumbens*); blueberry (*Vaccinium uliginosum*); fireweed (*Epilobium angustifolia*); cottongrass (*Eriophorum* sp.) Lichens and mosses--feather and sphagnum--are similar to those of Alaska, if not the same species. Larch (*Larix dahurica*) is the primary tree species, while upland shrubs are dominated by pine (*Pinus pumila*).

The region is undeveloped except for a widespread mining effort (the Kolyma River Basin and Magadan Oblast are important in U.S.S.R. gold production), and in many respects it resembles much of interior Alaska in the 1940's. Agriculture is just beginning, with collective farms located only near the major towns. Much transportation is by air, though Stokovaya is accessible by road (dirt/gravel) from Magadan, a 7- to 10-hour drive.

ITINERARY, WITH DISCUSSION

Slaughter and Bilello met in Khabarovsk, U.S.S.R., on 5 August 1976. Bilello had travelled to Khabarovsk from Leningrad while Slaughter had travelled from Alaska via Japan (Tokyo and Niigata). Both were met in Khabarovsk by Yuri Stoma, translator from the staff of the Northern Interdisciplinary Institute, Magadan. Mr. Stoma provided translation services for the entire 14-day visitation. Following unexplained delays, departure from Khabarovsk was at 0100, 6 August, with arrival at Magadan at approximately 0430.

The party was met at the Magadan Airport (about 30 km from the city) by A.S. Kuznetsov and G.V. Rumyantsev (Fig. 2) of the Kolyma Survey, U.S.S.R.

Figure 3. Street scene, Magadan--park near city center.

Figure 4. Street scene, Magadan.

Figure 5. Street scene, Magadan--sidewalk vendors.

Hydrometeorologic Service. After several hours rest at a local hotel, the schedule outlined in Appendix A (provided by the Soviets on arrival) was started. That schedule was adhered to rather rigorously through the first week of the visit, but was later compressed to enable Bilello to reach Moscow before his Russian *visa* expired on 19 August.

A summary of the itinerary and comments on specific points follows:

6 August:

Rest at Tsentralnaya Hotel, Magadan.

Briefing on mission and functions of the Kolyma Survey, U.S.S.R. Hydrometeorologic Service (KSHS), by G.V. Rumyantsev and staff.

Walking tour of Magadan (Figs. 3, 4, and 5)

Briefing tour of Northeast Interdisciplinary Research Institute, conducted by Dr. L.I. Izmailov, Deputy Director; the entire touring group attended a retirement ceremony for an Institute research worker.

Short tour of Institute of Biological Problems of the North (IBPN).

Dinner at Primorski Restaurant, hosted by Dr. Rumyantsev and KSHS staff.

7 August:

Helicopter flight from Magadan to Kolyma Water Balance Station (KWBS), on Kontaktovy Creek in the headwaters of the Kolyma River Basin; included flight over the Kulu River, a primary tributary of the Kolyma,

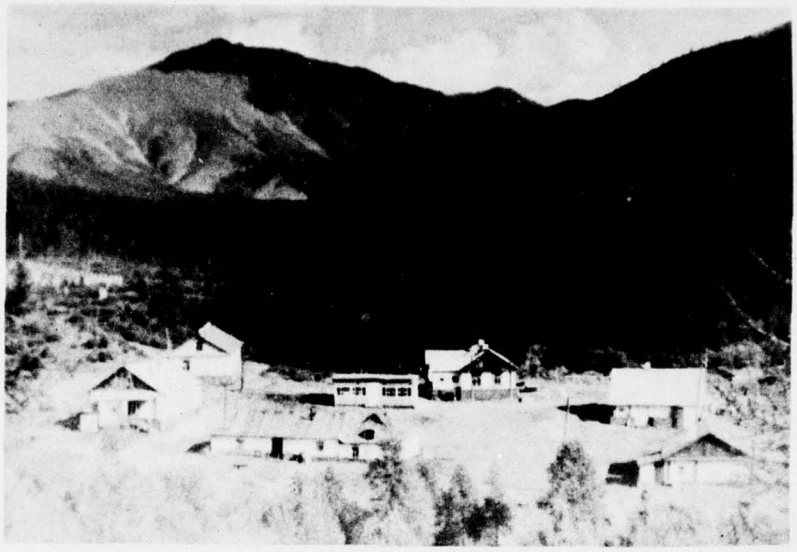


Figure 6. Kolyma Water Balance Station--view of main camp.

Figure 7. Kolyma Water Balance Station--another view of main camp.

Figure 8. Part of KWBS staff. From left: Y. Korolyov, C. Slaughter, A. Korekovtsev, A. Kuznetsov, V. Glotov, E. Boyarintsev, L. Boyarintseva, M. Bilello, A. Ipatyeva, V. Dovbysh, Y. Stoma.

and allowed some views of extensive gold mining activities (dredging, hydraulic operations). Unfortunately, no photos were allowed from the air.

Introduction to KWBS staff; V. Dovbysh, Resident Head of Station. General familiarization with the main KWBS "camp" (a year-round resident facility with 16 permanent and 8 part-time hydrologists, engineers, meteorologists and technicians employed (see Figs. 6, 7, and 8 and App. B).

8 August

Trip to Kulu River, upriver by boat (furnished by Kulu Collective Farm); fishing, picnic on river bank (Figs. 9 and 10). Unlike glacially-fed rivers of interior Alaska, the Kulu was completely clear. It apparently sustains little use or input of sediments upstream from the Kulu Collective Farm.

9 August

Briefing on mission and physical setting of KWBS, delivered by A. S. Kuznetsov. There are 20 hydrometeorological or water balance research stations in the U.S.S.R.; these, including the Kolyma Water Balance Station, are responsible to Voldaya Hydrologic Research Laboratory and the Leningrad Hydrometeorological Institute. KWBS is the only such hydrologic research station located in a permafrost region.

The primary orientation of KWBS is toward defining discrete elements of the water balance--precipitation, condensation, evapotranspiration,

Figure 9. Boat trip on Kulu River (M. Bilello, Y. Stoma, and Collective Farm Manager at tiller).

Figure 10. Picnic on bank of Kulu River. Featured fish soup, fresh tomatoes and cucumbers, local caviar. From left: C. Slaughter, V. Dovbysh, S. Dovbysh, Anatoly (driver), A. Kuznetsov, A. Korekovtsev, M. Bilello, V. Glotov, Collective Farm Manager.

change in soil moisture storage, change in groundwater. KWBS is the "standard" for northeast U.S.S.R., though there are approximately 20 other "water balance stations" (streamgaging sites?) in the northeast. KWBS serves two primary functions:

(1) Scientific--to determine, for a small area, all the water balance elements for the principal environmental conditions of the northeast;

(2) Applied--to determine "standard" water balance values which may be applied to river basins where economic activities (agriculture, mining) are carried on. KWBS is completely undisturbed except for timber cutting for house logs and fuel, mostly in the early years of the station. It thus provides a baseline for evaluation of the effects of economic activities.

The dominant concern in this region is mining, primarily gold dredging. It was stated that a preliminary report has been prepared concerning a three-year hydrologic investigation in mining areas, but that report was not available. Irrigation was mentioned as being of interest to agriculture, but it is not studied at KWBS.

KWBS was initially organized in 1948, with emphasis on stream runoff measurements. The first two climatic stations were near the main camp, at 840-m elevation, and on the westernmost basin divide at 1212-m elevation; the latter station was closed after 20 years operation. The total catchment area of KWBS is 21.2 km^2; catchment areas of principal sub-basins (Fig. 11) are:

Sub-basin	Drainage area (km^2)
Morozov Creek	0.7
Upper Kontaktovy Creek	15
Vstrecha Creek	5.35
Severny Creek	0.38
Yuzhny Creek	0.27

Based on their investigations to date, the Soviets have concluded that runoff (the ratio of precipitation to yield as streamflow) is higher in the northeast than in western U.S.S.R., because of lower evapotranspiration in the northeast interior. The increase of both precipitation and runoff with elevation was stressed, as was the role of talus slopes in this region (see discussions of August 10). The dominant role of the "forest floor," from living plant cover down to mineral soil, in controlling streamflow was also stressed. The Soviets apparently felt that, given all other factors equally, the actual catchment area of a basin does not in itself affect runoff. The depth to permafrost, including the progression of seasonal thaw in the active layer, is considered important to runoff determination, "all other conditions being equal."

Tour and explanation of primary meteorologic site at main camp (Fig. 12), conducted by N. Shirobokova, Chief Meteorologic Technician. A resident staff of four (N. Shirobokova and three assistants, including her husband, Y. Shirobokov) has responsibility for the meteorological observations at KWBS.

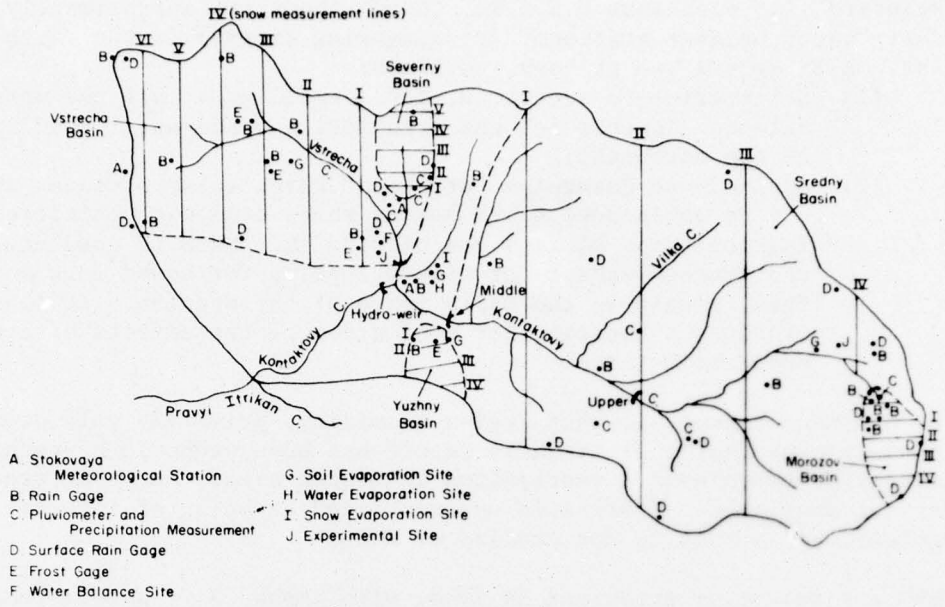


Figure 11. Map of Kolyma Water Balance Station.

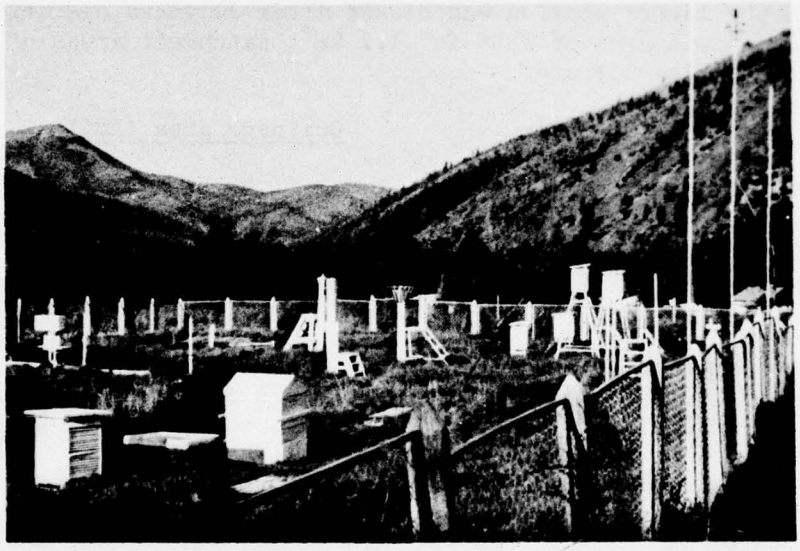


Figure 12. Central Meteorological site, KWBS.

This very complete climatic station was equipped to measure all standard parameters, including: 1) air temperature at 0.5 and 2.0-m heights (T_{max}, T_{min}, every 3 hours); 2) dewpoint (wet and dry bulb every 3 hours); 3) relative humidity (continuously recording hygrometer with daily chart); 4) precipitation (collector read four times daily, at 0800, 1100, 2000, 2300 hours, and recording pluviograph--collector with float recorder--with daily chart); 5) solar radiation (recording actinograph, and pyranometers for incoming and reflected

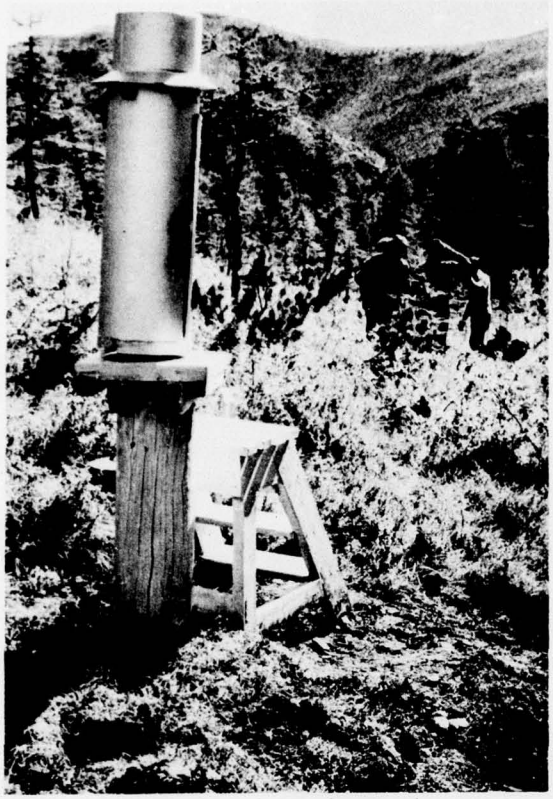


Figure 13. (a) Recording precipitation gage, Severny Basin

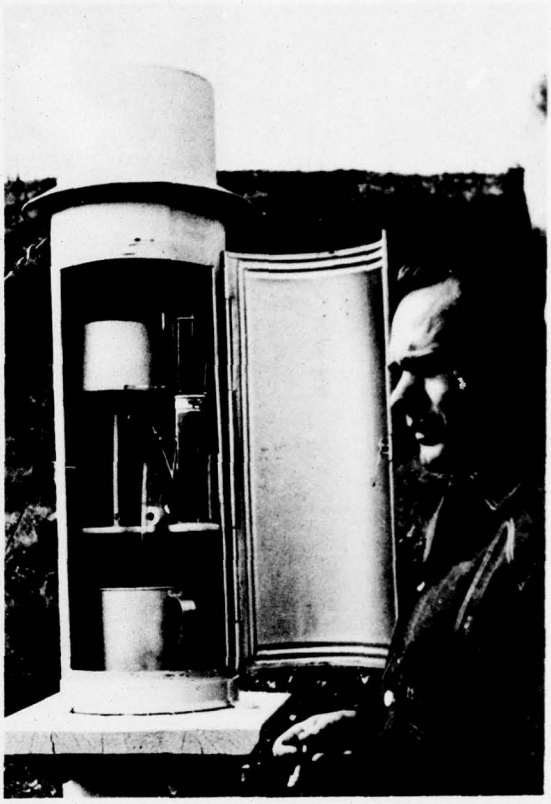


Figure 13. (b) float-operated recording mechanism.

shortwave, read with galvanometer 6 times daily); 6) wind (at 0.5-m and 0.2-m levels, totalized for 10-minute periods 6 times daily); 7) wind direction and velocity at 11-m height observed visually 8 times daily); 8) frost or rime observed visually during periods of accumulation on horizontal wires; 9) soil temperature at 5-, 10-, 15- and 20-cm depths under both cleared and vegetated sites were measured periodically with mercury or alcohol thermometers, and from 2-cm to 320-cm depth measured with thermistors.

Visit to Severny Basin, drainage area 0.38 km^2. This catchment has a cover of 35% talus, 45% *Pinus pumila*, and 20% *Larix dahurica*. Permafrost is continuous, 300 to 400 m thick. The active layer (zone of seasonal thaw) is 30 to 40 cm in wet valley areas, and up to 3-4 m on talus slopes. Observations in this catchment began in 1958. Precipitation is measured at 8 points in the basin, by recording gages (Fig. 13) with 5-day charts. Snowfall is measured along five established lines (Figs. 14 and 15), extending completely across the catchments; snow depth is measured every 10 m and snowpack water equivalent is measured every 100 m.

In 1975, a below-average-precipitation year, the mean snowpack water equivalent at maximum accumulation was 99 mm. Streamflow is measured in a steel flume, with stilling well and float recorder. Recorder

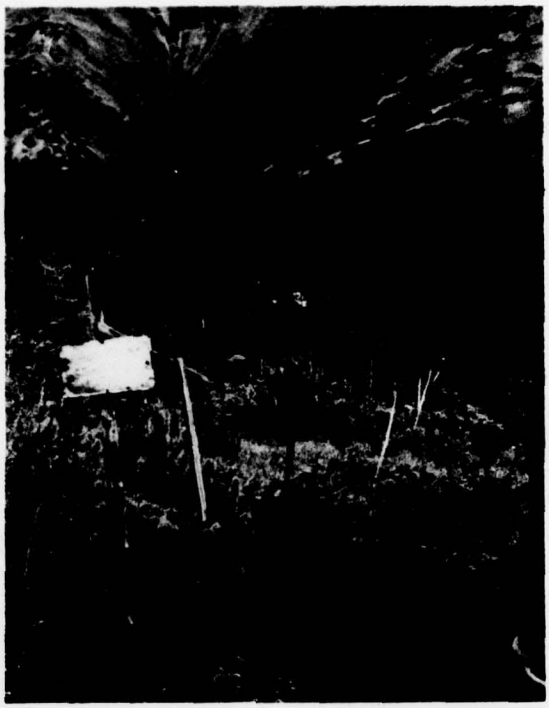


Figure 14. Snowpack measurement lines transverse to principal drainage, Vstrecha Basin. Measurement points marked by stakes at 10-m intervals.

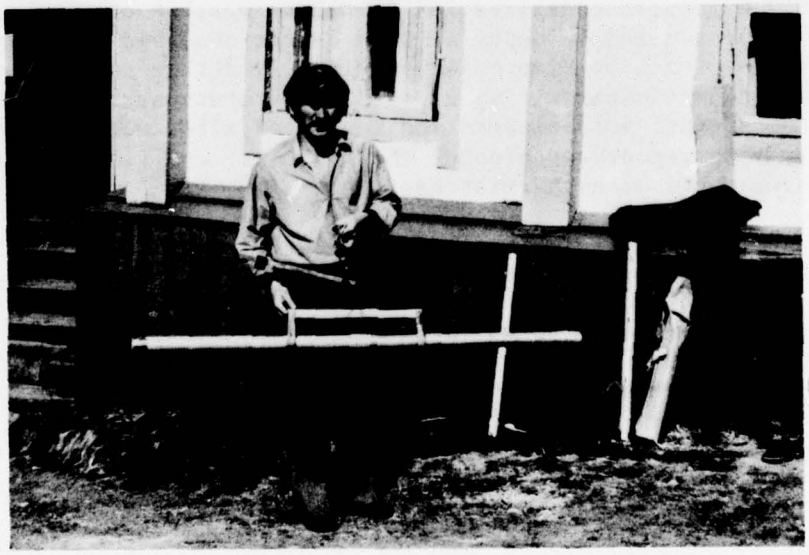
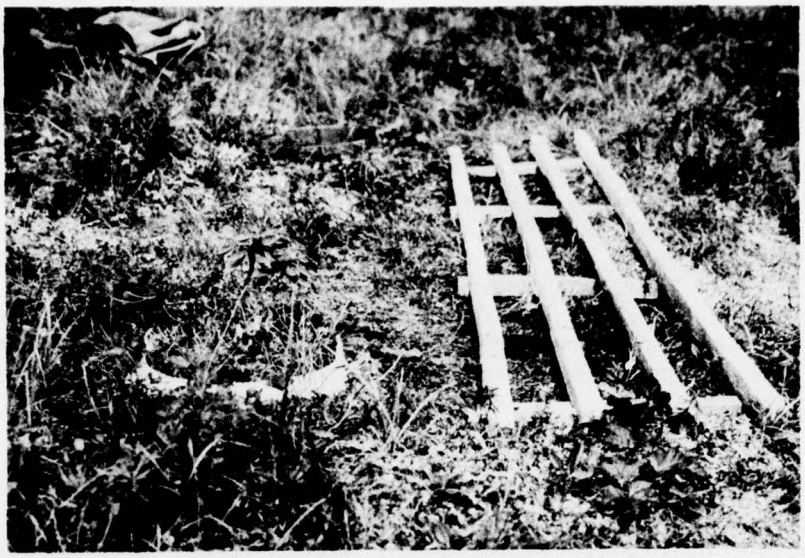


Figure 15. Snow measurement cylinder and weighing scale. (E. Boyarintsev holding scale.)



(a) Installed in soil mantle to left of walkway.

(b) Being weighed for determining change in moisture (V. Mikhailov).

Figure 16. Cylindrical soil evaporation lysimeter.

charts are changed daily, and the flume is electrically heated for winter flow measurement.

Visit to lower Vstrecha Creek Basin; the total catchment area of 5.35 km^2 includes Severny Creek. The cover of this basin is composed of 30% talus, 26% pine, 46% larch, and 1% bog. Precipitation is measured at 10 points within the basin, at daily, 5-day, or monthly intervals depending on distance from the base camp.

Evapotranspiration is measured at two "water-from-soil" sites in this basin (there are four such sites in the KWBS watershed). These consist of cylindrical lysimeters, 500-cm^2 surface area, holding a core of soil and undisturbed vegetation (Fig. 16). The top of the lysimeter is set flush with the surrounding surface; samples are weighed at 5-day intervals through the growing season, and results corrected by precipitation gage data if rainfall has occurred. Average net loss over a 5-day period is 5-6 mm of water and maximum observed loss is about 10 mm of water. Streamflow is measured in a metal flume, with stilling well and float recorder; recorder charts are changed daily, year round. This streamgage included flow from Vstrecha Creek and Severny Creek.

10 August

Visit to upper reaches of Vstrecha Creek Basin, led by V. Dovbysh. Inspection of precipitation gages, soil moisture evaporation site, avalanche observation points, snowpack measurement "transects." Snow depth is measured at 10-m intervals, along six marked lines running from ridgeline to ridgeline; snow water equivalent is measured at 100-m intervals. The frequency of snowpack measurement, depending on site, is every 10 days from date of first snow, monthly or annually at maximum accumulation. Maximum snow depths observed in some basins at the Kolyma Water Balance Station are given in Appendix C. Spring snowmelt begins in mid-April; snowpack density prior to spring melt ranges from 0.14 to 0.26 g/cm^3.

Lunch, briefing on biological investigations by Yu. B. Korolyov, of the Institute of Biological Problems of the North. Korolyov is attempting to relate streamflow to vegetative cover of upland basins. His summer field camp is a cabin no longer used by KWBS personnel.

Visit to lower Vstrecha Creek; inspection of 10-m^2 soil mantle evaporation station where separate "baskets" of soil and vegetation are individually weighed at weekly intervals (Fig. 17). Samples are changed yearly at time of maximum seasonal thaw, and weighed periodically (weekly or after every major rainfall).

Visited large runoff plots (initiated in 1969), 200-m^2 surface area each, where runoff from top 10 cm and next lower 100 cm of the soil mantle is monitored. Site elevation is 870 m. Plots are isolated from surroundings by wood piling, driven to permafrost; results are unpublished, but a monograph, "Hillslope Runoff," was apparently being prepared and a copy may be available in Magadan. The Soviets showed great interest in this subject of surficial runoff and "interflow."

Visit to talus slope runoff and condensation site (initiated in 1971), located on north-facing, 100% slope of loose talus (basalt) (Fig. 18). Includes 1) barrel condensator, a steel drum buried in the talus, filled with rock and equipped with drain hose and recorder; 2) square pit condensator (Fig. 19), with porous sides (to allow lateral vapor transfer) but with closed bottoms and provision for measurement of water yield; one pit was covered to exclude precipitation but presumably

(a) Installed in soil mantle (A. Korekovtsev).

(b) Soil monolith excavation site, showing depth of soil development over shale substrate (V. Glotov).

Figure 17. Rectangular soil evaporation basket lysimeters and soil monolith excavation site.

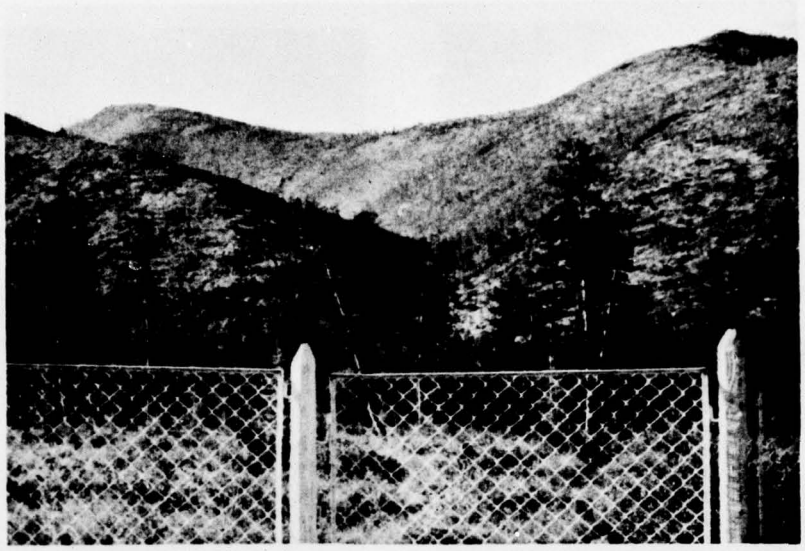
to still allow condensation or evaporation and lateral vapor movement.

The effort expended on this talus slope installation evidenced deep concern with the role of talus slopes in yielding water for streamflow; this was discussed at length, because the Soviets feel that condensation on talus rock surfaces is a major factor in augmenting water

Figure 18. Talus slope runoff and condensation measurement site.

Figure 19. Rectangular, mesh-walled "pit condensator" installed in talus slope; uncovered pit in foreground, covered pit in background. From left: A. Ipatyeva, Y. Stoma, A. Kuznetsov, E. Boyarintsev, V. Glotov, A. Korekovtsev.

yield of such slopes (see later discussion of Morozov Creek). An extensive discussion was conducted on the publication of preliminary results; the Soviets indicated that they would like to obtain a high degree of certainty before disseminating any available data.



(a) View from KWBS main climatology site.

(b) Ravine below Yuzhny Creek streamgage.

Figure 20. Yuzhny Creek watershed, illustrating open lichen/larch forest cover.

11 August

Visit to Yuzhny Basin streamgage (the smallest gaged basin in KWBS, 0.27 km^2) in a north-facing, open lichen/larch cover watershed (Fig. 20). The streamgage, with daily chart change on the water level recorder (Fig. 21), is located in a narrow draw; a 90^{o} V-notch weir is supplemented by a 20^{o} V-notch for low-flow measurement (Fig. 22); cutoff walls extend laterally 3 m into the banks to bedrock, and vertically 2 m.

Figure 21. Water-level recorder; horizontal drum with 24-hour chart, spring-driven clock and float in stilling well.

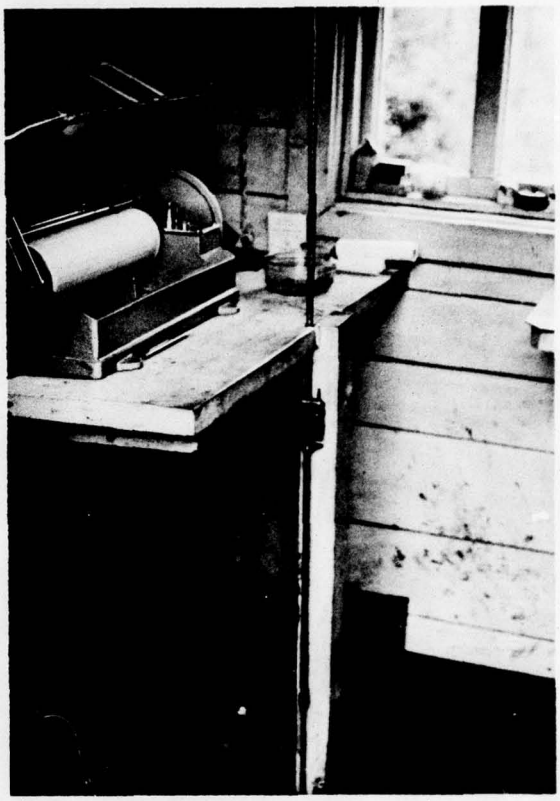


Figure 22. Yuzhny Creek streamgaging installation. V-notch weir, float-actuated water level recorder in house, rectangular container below weir blade (mounted on rails) for volumetric discharge measurement.

Provision is made for volumetric measurements of discharge, utilizing steel tanks mounted on rails which can be positioned to catch the entire runoff below the weir. The weir is electrically heated in winter to allow continuous discharge measurement. The Soviets stressed the significance of the deep moss-lichen ground cover and shallow active layer in this north-facing watershed and, presumably, the consequent low total evapotranspiration losses relative to the losses of other watersheds of KWBS.

Inspection of precipitation gage, soil evaporation station utilizing circular "evaporimeters" (lysimeters) with 500-cm^2 surface area.

Briefing by Dr. Vladimir Ye. Glotov, Chief of Groundwater Investigations, Northeast Geological Survey. The hydrogeology investigations are primarily oriented toward securing adequate water supplies, particularly in winter, to support mining operations (dredging) in Magadan Oblast. Groundwater observations at KWBS were initiated in 1960, with a network of groundwater wells at the Sredny and Nizhny streamgaging sites of

(a) Painted oil drum protects well casing above ground (M. Bilello, E. Boyarintsev).

(b) Measuring temperatures in well near Sredny gaging site (V. Glotov facing camera).

Figure 23. Groundwater observation well.

Kontaktovy Creek. At the Sredny (middle) gaging site, wells (Fig. 23) are 4 m deep, the first 3 m through unconsolidated coarse gravel. Three wells extend through permafrost, 160 to 190 m. Problems of maintaining unfrozen wells through permafrost were discussed; the techniques have included physically breaking out ice with metal rods or gunfire, and using antifreeze solutions and heat cables.

Resistivity mapping of the Sredny site was accomplished in 1966, and a map delineating thawed gravel zones along the stream channel was prepared. Salt dilution techniques were utilized to determine flow velocities of groundwater: 44 m/hr beneath the stream channel; 8 m/hr 2 m north of the channel; and 1-2 m/hr further from the channel (all measurements done in August). Lower groundwater velocities were measured in Vstrecha Creek: 26 m/hr beneath the channel; 1/2 m/hr away from the channel.

Dr. Glotov stated that KWBS is not necessarily "representative" geologically of the whole of Magadan Oblast's mining region, but it is attractive to work in because it is "hydrologically representative" and offers a variety of geologic settings for study. The Northeast Geological

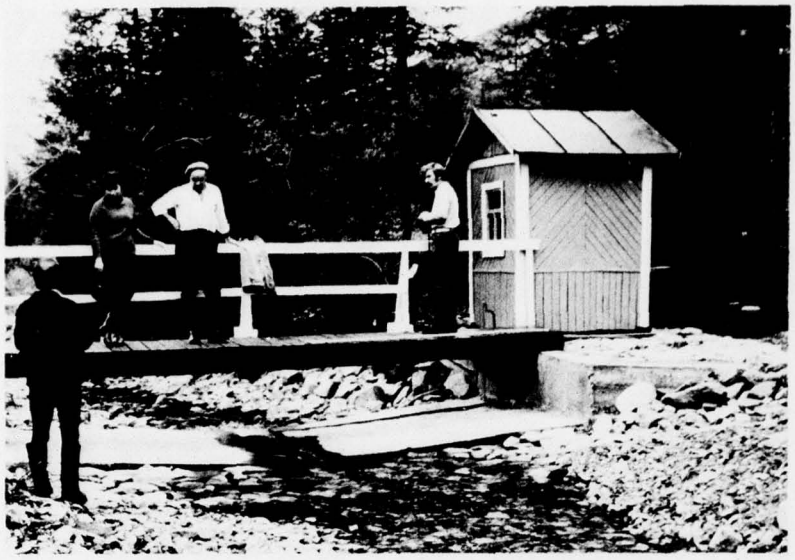


Figure 24. Nizhny streamgaging site, with broad-crested concrete weir, float-driven water level recorder in shelter (A. Korekovtsev, A. Ipatyeva, A. Kuznetsov, E. Boyarintsev).

Survey stations one man full time at KWBS to maintain readings in the groundwater well. Neutron probe measurement of soil moisture levels had been attempted but was discontinued two years ago.

Dr. Glotov emphasized the concept that mining (dredging) can effectively increase groundwater storage of valleys in permafrost regions. The theory is that by thawing the valley soils, flushing out fine materials and redepositing coarse, thawed materials in lowlands, thawed taliks are created which can be recharged by surface runoff. Such artificial aquifers can then be utilized as a freshwater source, particularly valuable in winter.

Ground temperatures are measured in several wells near Kontaktovy Creek; in the one closest to the Sredny (middle Kontaktovy Creek) streamgage, maximum depth was 3.2 m (less than the annual active layer). Temperatures measured 11 August 1976 in the well were:

Depth (m)	Temperature (^{o}C)
0.8	1.4
1.5	0.8
2.5	0.70

Visit to the Nizhny (upper Kontaktovy Creek) gaging site, a new (spring 1976) installation. The streamgage (Fig. 24) consists of a low-angle broad-crested concrete weir, 40 cm thick, connected by open channels to a conventional stilling well and water level recorder. Because of occurrence of naleds (icings) in this section of the valley, no cutoff walls were installed, either laterally or beneath the weir. The rationale was twofold: possible interruption of natural flow regime beneath

Figure 25. Morozov Creek watershed, virtually free from vegetation and largely talus-covered; streamgaging site at middle-left of picture.

and adjacent to the channel and possible initiation of naled formation at the gaging site, and assumption that existence of a persistent naled site 300-m downstream indicated a natural groundwater cutoff, thus negating any need for artificial cutoff walls. This weir installation cost between 2,000 and 5,000 rubles (they used their own labor), which was considered less expensive than the Parshall-type flumes installed at other sites. This site is planned for ten years operation.

Near the Nizhny site, a deep well (235 m) was located through 210 m of frozen ground. This well had been instrumented for temperature measurements by thermocouples at 0.4-m intervals from the surface to 20 m, then at 10-m intervals down to 190 m; the well has been allowed to refreeze.

12 August

Trip to Morozov Creek, a vegetation-free, talus-covered watershed in the southeast headwaters of Kontaktovy Creek (Figs. 25 and 26). The streamgaging station, established in 1969, is about 3 hours walk from the main camp; two technicians (S. Suschansky, N. Lazuk) are stationed at this site during 5 months of the year. The drainage area above the

Figure 26. Storage precipitation gage on alpine slope, north of Morozov streamgaging station; view down-valley to west.

Figure 27. Streamgaging site on bedrock outcrop at lower terminus of Morozov Creek watershed (view downstream).

V-notch weir is 0.7 km^2. Five precipitation gages are situated in the watershed and five snow-measurement lines extend across the catchment from north to south. Streamflow is measured at a natural bedrock outcrop in a metal flume with V-notch weirblade (Fig. 27), utilizing a float recorder.

Based on two years of precipitation/runoff data, runoff at this basin is equal to 100% of precipitation. The Soviets, particularly Dr. Kuznetsov, were greatly interested in studying the condensation question and eager to learn of any new instruments or techniques which we might suggest. Among our thoughts were simple profiles of temperature and relative humidity which could be measured using thermocouples and thermocouple psychrometers, or the Weather-Measure HM-111p solid-state humidity probe.

13 August

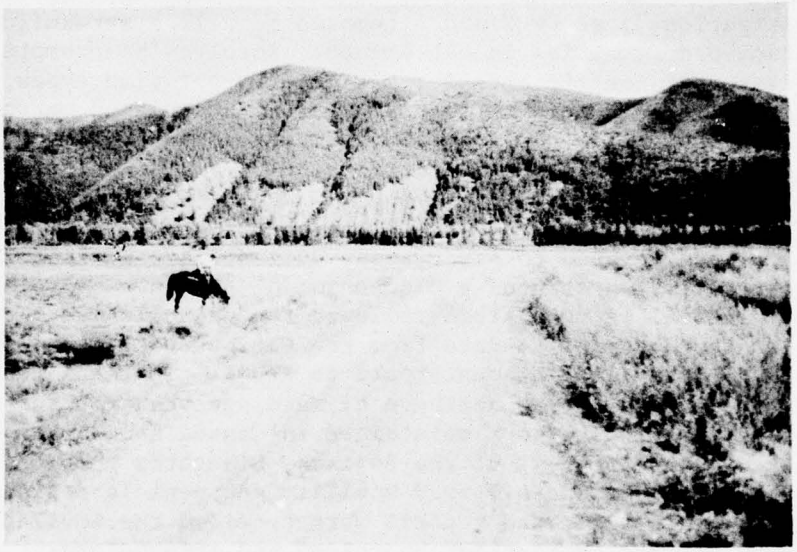
An office session at KWBS. A. Ipatyeva presented a discussion of precipitation and snowpack measurements. A.S. Kuznetsov lectured on runoff measurements and A.S. Korekovtsev presented a discussion on measurement of evaporation (net evapotranspiration as measured gravimetrically by their methods). V. Glotov presented a good discussion on groundwater and hydrogeology relationships in permafrost regions. Yu. B. Korolyov lectured on his vegetation mapping ("Geo-botanical Investigations") at KWBS and attempted to relate streamflow to major vegetative communities in catchments. Korolyov's attempts to define annual runoff coefficients for six major vegetative types, independent of elevation, exposure or catchment area, stimulated extensive and spirited discussion among the Soviet hydrologists present.

14 August

This day was devoted to discussions by the visiting Americans. C. Slaughter first presented a discussion of Alaska's hydrologic and climatological setting, then reviewed the establishment, operation, and results obtained to date from the Caribou-Poker Creeks Research Watershed (the Alaskan counterpart to KWBS). In the afternoon, M. Bilello lectured on his northern climatology research and the snow and ice reporting network maintained in Canada and in the United States. At the request of the Soviets, Slaughter provided a brief discussion concerning off-road mobility and vehicle design and usage. A number of reprints and reports were provided the Soviets concerning the U.S. efforts in northern hydrology and climatology.

In the evening, Dr. Daniel I. Berman visited Stokovaya. He is head of the Biocenosis Ecology Lab, Institute of Biological Problems of the North (IBPN) (Magadan), and is responsible for environmental impact studies relating to the planned hydropower development at Obo, in the upper Kolyma Basin. Discussions concerned his ecosystem studies, the unique hydrometeorological conditions of permafrost regions, and construction problems encountered in these areas.

Figure 28. Gold mining, Kolyma River Basin. Overburden removal by tractor and dragline is followed by thaw of frozen gold-bearing sediments and gold separation by dredge.



(a) General view of fields and river bluffs.
Figure 29. Kulu Collective Farm, 15 km from Stokovaya.

15 August

The morning was devoted to a 5-hour trip by jeep, led by Dr. Glotov, to the Dnadyer River, which joins the Kulu River to form the Kolyma. This trip allowed viewing a variety of terrain and vegetative types and provided a look at some of the extensive gold-mining operations in the Kolyma headwaters. Hydraulic operations, extensive use of

(b) Thermokarst depression in field cleared on ice-rich silts.

(c) Viewing thawed silts, stubble from oat/pea crop. (From left, C. Slaughter, Farm Manager, V. Dovbysh, Y. Stoma, A. Kuznetsov).

Figure 29, cont'd.)

bulldozers (Fig. 28) and draglines for overburden removal and material stockpiling, and dredging were observed.

This trip was followed by a brief visit to the Kulu Collective Farm, where problems of settlement from thawing of ice-rich soils (thermokarst development) and of boggy soils (obviously ice-rich silts) were viewed and discussed (Fig. 29). The late afternoon was devoted

to a short boat trip and picnic on the Kulu River. Dr. Rumyantsev and Mr. Boitsev, both of Kolyma Hydrometeorological Survey, arrived at KWBS the afternoon of 15 August.

16 August

The entire day was devoted to preparation of a series of proposals for future cooperative work in hydrology, between the Soviets, led by Rumyantsev and the Kolyma Hydrometeorological Survey, and the United States. The skills of Mr. Stoma, our interpreter, were sorely taxed this day but agreement was reached on a proposed program. This agreement was typed (in Russian) for signature 17 September 1976; copies of both the Russian original and the English translation, prepared by Stoma and Slaughter, are attached (App. D). The evening of 16 August was devoted to a festive dinner attended by virtually the entire KWBS staff. Excellent food was followed by many toasts, much music and dancing to the small hours--a fitting ending for the exchange visit!

17 August

The morning was devoted to interviews of Bilello and Slaughter, recorded on video tape for U.S.S.R. television*, presumably at Vladivostok or Khabarovsk, and to a briefing by L.I. Boitsov concerning runoff forecasting. That lecture, as well as plans for lunch, was cut short by announcement that a helicopter would arrive at 1215 to transport us to Susuman. Hurried packing and final farewells (Fig. 30) were followed by a 30-minute flight to the town of Susuman on the Berelyakh River. The Americans were accompanied by Rumyantsev, Kuznetsov, Boitsov, Glotov, Ipatyeva, Korekovtsev, and Stoma. This flight provided overviews of very extensive gold-mining operations and developing agriculture (collective farms), which from the air closely resembled farming in the Tanana Valley of Alaska.

Travel from Susuman to Magadan was by Aeroflot turbo-prop. In Magadan, Rumyantsev and Kuznetsov arranged for a hotel room in the vicinity of the airport, where Bilello and Slaughter waited about 6 hours for a flight to Khabarovsk. That flight departed Magadan at about 2250 hours, arriving at Khabarovsk at 0230 hours, 18 August.

18 August

On arrival at Khabarovsk, immediate steps were taken to arrange for travel to Moscow for Bilello; he left Khabarovsk at about 0600 hours. Slaughter's scheduled departure was by Japan Airlines on 19 August, so he spent 18 August in Khabarovsk in the company of Y. Stoma. Part of the day was spent preparing the final English version of the proposals which up to that time were only available in the Russian. Departure from Khabarovsk was on the afternoon of 19 August 1976.

*Notice of this exchange visit was also taken by the Soviet press (see APP.E).

(a) Part of KWBS at dining hall. From left, V. Dovbysh, L. Boyarintseva, A. Ipatyeva, G. Puzanova, Z. Nazarova, T. Rudneva, R. Dovbysh, I. Muzychuk, Yu. Boitsov, G. Rumyantsev, A. Korekovtsev, and E. Boyarintsev.

(b) Boarding Aeroflot helicopter in streambed below KWBS.

Figure 30. Departure from KWBS (Stokovaya).

RESULTS

The most obvious result of this exchange visit is the document, "Proposals for Cooperation," which was prepared at the termination of the visit (App. D). Meaningful implementation of these proposals must await further high-level agreement between the Soviet Union and the United States; all the participants believe that both sides will gain technically from such implementation.

A more immediate positive result is embodied in the understanding gained by the U.S. scientists of Soviet hydrologic research in permafrost uplands. During this visit, a number of impressions or facts were noted which are relevant to corresponding research in the U.S. cold regions. These include the following:

1. A very positive impression was gained of the scope, intensity, and continuity of hydrometeorological data collection at KWBS. This results not from sophistication of instrumentation, but rather, from a good supply of technically trained personnel resident at KWBS and their dedication to accomplishment of the entire data acquisition task on a year-round basis, often under rigorous climatic conditions.

2. A very favorable impression was gained of dedication to minimal disruption of the local environment during conduct of the hydrometeorological studies. Examples of this include the restriction of all travel to remote sites to foot traffic, with four-wheel drive trucks used only to transport the heaviest loads and then only under conditions of minimal impact (while the ground is frozen). This concern with the preservation of nature was mentioned many times during the visit (though it was not necessarily evident at other locales observed while travelling to and from Stokovaya).

3. A lack of concern with study of environmental factors not directly related to the water balance was noted. For example, despite the excellent streamflow measurement network and available personnel at KWBS, there have apparently been no parallel measurements of water temperature or chemistry, (i.e., pH, turbidity, suspended sediment, dissolved oxygen, etc.). Such baseline data are not viewed as directly relevant to water balance and, hence, are not included in the measurement program.

4. The heavy emphasis at KWBS on manpower for field studies and data tabulation has both positive and negative aspects. Such labor, when available, allows utilization of simpler and probably more reliable instrumentation, hence, the apparently excellent quality and continuity of hydrometeorological data that were observed. However, efficiency might be improved by utilization of more sophisticated instrumentation, such as data telemetry systems or automatic data processing (ADP) equipment at the field laboratory. The availability of resources to the Magadan Hydrometeorological Observatory and KWBS undoubtedly determines their decisions in this regard.

5. The very real desire for cooperation with U.S. investigators in hydrometeorological studies in Magadan and Alaska can be considered a *positive* result of this visit. The personal contacts that this trip allowed should be useful in pursuing two-way communication and, hopefully, cooperation in subarctic hydrology studies. The Soviet interest in this cooperation can only be viewed as encouraging, and it is to be hoped that the Soviets will reciprocate by sending several of their scientists to Alaska in 1977 for a similar visit.

RELEVANCE TO ALASKAN RESEARCH

A major reason for U.S. interest in visiting the Kolyma Water Balance Station was its possible similarity to an existing permafrost-environment hydrologic research area in Alaska, the Caribou-Poker Creeks Research Watershed near Fairbanks. A synopsis of the latter activity and site is provided in App. F.

Many parallels between these two areas are evident. Both encompass complete, essentially pristine drainage basins; in both, a basic hydrometeorologic data acquisition system has been designed and installed; in both, characterization of environmental features relevant to hydrology has been undertaken (i.e., soils and vegetation mapping). Both are in permafrost-dominated locales, though KWBS is completely underlain by permafrost while the south-facing slopes of Caribou-Poker Creeks are permafrost-free.

There are also significant differences between the two areas. Caribou-Poker Creeks Research Watershed is the larger of the two (104-km^2 vs 21.2-km^2), but has fewer steep-alpine regions. Extensive talus slopes such as those of Morozov Creek are entirely lacking in Caribou-Poker Creeks. Vegetation is similar in many respects, though the principal central Alaskan conifers, black spruce (*Picea mariana*) and white spruce (*Picea glauca*) are replaced in the Kolyma by Siberian larch and the *Pinus pumila* high shrub. Extensive stands of hardwoods (*Betula papyrifera, Populus tremuloides*) are found on south-facing slopes of Caribou-Poker Creeks, but similar hardwood stands were not observed at KWBS or in surrounding areas.

KWBS was established nearly 30 years ago and, thus, has accumulated an admirable record of basic hydrologic data. The Caribou-Poker Creeks project was initiated in 1969, so its data base extends back only seven years at best. KWBS is administered by an agency with a very specific objective, delineation of the water balance and its principal components; Caribou-Poker Creeks is a cooperative, multi-agency effort administered by an inter-agency committee and one "lead" agency*, with the dual objectives of defining the subarctic upland hydrologic regimen and of providing a field setting suitable for integrated environmental research, oriented toward natural resources management.

*Currently, the Institute of Northern Forestry, U.S. Forest Service, Fairbanks, Alaska.

Operations in the two areas differ principally in staffing and instrumentation. At KWBS, a year-round cadre of up to 24 hydrologists, climatologists, and technicians is resident in the research area, with backup and direction furnished by the Hydrometeorological Observatory in Magadan. There are obvious advantages in having personnel living in close proximity to the research area. As noted previously, this large resident staff, with enthusiastic workers, permits frequent on-site measurements or observations of instrument functioning, and allows use of field recorders having short time spans (such as 24-hour charts on water-level and precipitation recorders) and consequent high resolution. Frequent (often daily or twice-daily) instrument servicing should result in few gaps in the data record.

In contrast, the Caribou-Poker Creeks effort has rarely had more than five persons (scientists and technicians) directly involved in the watershed operation, and only since 1975 have there been two persons on full-time assignments to the project. Most field operations have been based in Fairbanks, over 40 km south of the watershed. There has necessarily been greater reliance on long-term *in situ* hydrometeorological recording instruments, with less than desirable frequency of field servicing. Consequently, there are annoying gaps and omissions in some records. There recently has been considerable attention given to developing real-time data telemetry systems in Alaska to help meet such site servicing problems (however, the increasingly sophisticated equipment required for telemetry entails more expense, as well as more advanced technical expertise when servicing is required). These manpower and distance constraints have also meant a much greater reliance on mechanized transportation and on trail development in Caribou-Poker Creeks than was seen at KWBS.

Despite these differences, the parallels in concept, data requirements, field measurement needs and approaches, and the environmental constraints of high-latitude, permafrost-dominated settings more than justify a continuing dialogue and cooperative program between U.S. and Soviet scientists in this area. Potentially fruitful areas for cooperation, elaborated in Appendix D, include baseline hydrometeorological data exchange, and cooperation in the problem of evaluating the hydrologic significance of condensation and evaporation in high-latitude catchments. It will be to the advantage of our respective research programs to maintain the lines of communication and the cooperative spirit which imbued this initial scientific visit.

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APPENDIX A: Schedule for Exchange Visit

(Presented in its original form)

KOLYMA SURVEY OF THE U.S.S.R. HYDROMETEOROLOGIC SERVICE

The Kolyma Survey of the U.S.S.R. Hydrometeorologic Service is a government-owned agency that is intended to supply governmental offices, national economic enterprises and general public with meteorologic and climatologic, aerological, agrimeteorologic, hydrologic and oceanologic data.

The Survey is entrusted with fulfilment of the following:

(1) investigation of hydrometeorologic regime on the territory of Magadan Region and seas around it through establishment of meteorologic, aerological, agrimeteorological, hydrologic and marine stations and posts, hydrologic observatories, and also organization of field trips and experiments;

(2) provision of governmental offices, national economic enterprises and general public with hydrometeorologic data, hydrometeorologic emergency warnings, meteorologic, hydrologic and agrimeteorologic forecasts, information on climate, agrimeteorologic conditions and hydrologic regime on rivers and seas;

(3) conduction of scientific research works in the field of hydrometeorology;

(4) summation and publication of observation materials as well as field facts and research results including printing annual publications, reference books, monographs, transactions, monthly editions, bulletins.

(5) organization and management of observations and tests to follow environmental pollution;

(6) promotion of hydrometeorologic knowledge among general public;

(7) stockpiling hydrometeorologic materials and carrying out miscellaneous works.

Main departments of the Kolyma Survey are as follows:

Management and administration workers are engaged in general guidance of all the departments of the K.S.H.S.; they provide governmental offices, national economic enterprises and population with every kind of forecasts and also hydrologic reference materials, emergency warnings and top emergency warnings.

Hydrometeorologic observatory is an industrial-technical as well as methodologic body engaged in studies of hydrometeorologic regime on land and sea, investigations of natural chemical composition and degree of environmental pollution, dangerous mudflows and landslides with subsequent handing the information in the relevant agencies; methodologic and technical supervision of a network of hydrometeorologic stations and posts (including automatic ones). The observatory also keeps hydrometeorologic records, sums up materials on hydrometeorologic regime, prepares them for publication and turns them over to designing agencies, national economic enterprises and offices. It also supervises the stock of hydrometeorologic information and scientific and technical data in the field of hydrometeorology.

Weather bureau is an operative industrial body that

carries out the following works on the territory it is in charge with: correlation of all types of forecasts and ordinary and emergency hydrometeorologic warnings; effective provision of governmental, national economic agencies with hydrometeorologic and agrimeteorologic data; investigation of needs of national economy in efficient hydrometeorologic information and its application; methodologic management of a network of prediction bodies.

Communication unit is an operative industrial body incorporated by KSHS that supervises communication means and also piles up and distributes hydrometeorologic data.

The KSHS Network includes hydrometeorologic, aviameteorological, specialized and automatic stations and posts as well as some auxiliary divisions, i.e. assembly team, check bureau, repairment team, hydrographic teams, etc.

PROGRAM OF THE U.S. SPECIALISTS' VISIT TO THE KOLYMA WATER BALANCE RESEARCH STATION OF THE KOLYMA SURVEY OF THE U.S.S.R. HYDROMETEOROLOGIC SERVICE

Magadan Region, U.S.S.R.
August, 1976

In accordance with:

-- the Agreement between the U.S.S.R. and the USA on Cooperation in the Field of Environmental Protection, signed in Moscow by Chairman of the Presidium of the Supreme Soviet N.V. Podgorny and President R.Nixon on 23 May, 1972;

-- the *Memorandum* adopted by the 4th session of the Joint Soviet-American Commission on Cooperation in the Field of Environmental Protection on Project V.2-1 (Protection of Ecosystems of Northern Regions), theme A-1 (Productivity and Functioning of Northern Ecosystems).

The target of the American specialists' visit to the water balance station is to become acquainted with elements of water balance research as possibly related to the study of the Northern ecosystems' productivity and functioning.

The time of the oversea specialists' staying is two weeks-from 5 to 19 August, 1976.

Time schedule and itineraries

August 5 (Thursday)

7:05 a.m. (Moscow time, or 2:05 p.m. Khabarovsk time). Arrival to Khabarovsk from Japan. The guests are met by interpreter Yuri Stoma and representative of the FE Survey of the U.S.S.R. Hydrometeorologic Service.

1:45 p.m. (or 8:45 p.m. local time). Leave Khabarovsk for Magadan, accompanied by interpreter.

August 6 (Friday)

0:45 a.m. (Magadan time). Arrival to the airport of Magadan. Meeting with Ghennady V. Rumyantsev, Head of the Kolyma Survey of the U.S.S.R. Hydrometeorologic Service.

2:00 a.m. Arrival to Magadan. Night rest at the 'Tsentralnaya' Hotel.

10:00-11:00 a.m. Breakfast at the 'Tsentralnaya' Hotel.

11:00 a.m.-1:00 p.m. Familiarization with scientific work conducted by the Kolyma Survey of the U.S.S.R. Hydrometeorologic Service (KSHS). The principal persons present on the Soviet side are G.V. Rumyantsev, A.S. Kuznetsov, A.I. Ipatyeva, Yu. A. Boitsov, Yu. V. Akhnazarova, L.P. Kuroshina, G.A. Ivanov, A.S. Korekovtsev, A.N. Chumak, R.V. Bykova.

1:30-2:30 p.m. Luncheon at 'Teatralnoye' café.

3:00-6:00 p.m. Acquaintance tour of Magadan visiting its main scientific institutions (N-E Interdisciplinary Research Institute, Institute of Biologic Problems of North).

6:00-7:00 p.m. Buying souvenirs at 'Almaz' shop.

7:30-10:30 p.m. Dinner at 'Primorski' Restaurant.

August 7 (Saturday)

8:30-9:00 a.m. Breakfast at 'Tsentralnaya'.

9:30 a.m. Departure for the '13 km airfield'.

10:00 a.m. Trip by helicopter to the Kolyma Water Balance Research Station (KWBS). Overflight in the area of the Kulu River. Stops at the upper reaches of Morozov Creek and Vstrecha Creek.

1:00 p.m. Luncheon at the KWBS.

3:00-6:00 p.m. Familiarization with the KWBS and its background including physical and geographical characteristic of the Station area, historical items, equipment and instruments, aims, observation materials and their representativity for the surrounding territory studies. Visit to the meteorologic gage sites. The Head of the KWBS is Vladimir N. Dovbysh. Reporters are A.S. Kuznetsov and N.V.

Shirobokova.

7:00-8:00 p.m. Dinner.

August 8 (Sunday)

Free from work day. Pleasure trip to the upper Kulu area.

August 9 to 11 (Monday-Wednesday)

Acquaintance with methods used in the field works, instruments and installations in the watershed of creeks Severny, Vstrecha, Yuzhny as well as at the research site Sredny.

Day 1

8:30-9:00 a.m. Breakfast.

9:00 a.m.-1:00 p.m. Visit to the Severny Creek. Demonstration of instruments including pan, pluviograph, pluviometers, snow gages.
Briefing talks on the works conducted at the Vstrecha Creek watershed.
The principal reporter is V.N. Dovbysh.

1:00-2:00 p.m. Luncheon break.

2:00-6:00 p.m. Continuation of observations. Demonstration of pan in operation at the Vstrecha Creek, water discharge information. Work of the research sites including a water evaporation site, water-from-soil evaporation site No.1, water-from-snow site.

The principal reporter is Ye.L. Boyarintsev.

7:00-8:00 p.m. Dinner.

8:30-10:00 p.m. Cultural and sporting events.

Day 2

8:30-9:30 a.m. Breakfast.

9:00 a.m.-1:00 p.m. Continuation of acquaintance with the Vstrecha Creek area. Visits to pluviometric site No.2, a week pluviograph, water-from-soil evaporation site No.6, snow gage lines.
Reported by V.N. Dovbysh.
Visit to the hut on the Dozhdemerny Creek; familiarization with the works conducted by IBPN there.
Comments by Yu.B. Korolyov.

1:00-2:00 p.m. Luncheon.

2:00-6:00 p.m. More information on the Vstrecha basin area. Visits to the watershed research sites.
Comments by A.I. Iaptyeva.
Moister content determination at gages. The tasks carried out there.
Reported by A.S. Korekovtsev.
Visit to the rain gage No.7. The work of condensator
Reported by A.I. Ipatyeva.

7:00-8:00 p.m. Dinner.

8:00-10:00 p.m. Cultural and sporting events.

Day 3

8:30-9:00 a.m. Breakfast.

9:00 a.m.-1:00 p.m. Visit to the Yuzhny Creek watershed area. Weir installation. Visit to the rain gage site No.20, sites of soil freezing observation and soil thawing research. Demonstration of water-from-soil evaporation site, pluviometers, snow gage lines.
Reported by Ye.L. Boyarintsev.

1:00-2:00 p.m. Luncheon break.

2:00-6:00 p.m. Visit to the Sredny site. Installations and water discharge gages.
Reported by S.I. Sushchansky.
Hydrogeological researches at the Kontaktovy Creek. Visits to the Sredny and Nizhny research sites.
Reported by V.Ye. Glotov.

7:00-8:00 p.m. Dinner.

8:00-10:00 p.m. Cultural and sporting events.

August 12 (Thursday)

8:30-9:00 a.m. Breakfast.

9:00 a.m. - 1:00 p.m. Reports on methods used for measurement and calculation of water balance elements at sites and watershed areas:

(1) Precipitation, by A.I. Ipatyeva

(2) Snow survey, by A.I. Ipatyeva

(3) Runoff, by A.S. Kuznetsov

(4) Evaporation, by A.S. Korekovtsev

(5) Experimental works, by A.I. Ipatyeva

1:00-2:00 p.m. Luncheon.

2:00-6:00 p.m. Hydrogeologic observations and their results. Part played by subterranean component in the watershed of the Kontaktovy Creek.
Report by V.Ye. Glotov.
Prognosis of maximum rain-induced floods and spring seasonal floods in the Upper Kolyma area.
Report by Yu.A. Boitsov.

7:00-8:00 p.m. Dinner followed by cultural and sporting events

August 13 (Friday)

8:30-9:00 a.m. Breakfast.

9:00 a.m. - 1:00 p.m. Visit to the Verkhny research site, crest of weir operation. Works at pluviometric point No.25. Functioning of totaliser, pit pluviometer, week pluviograph.
Comments by Boyarintsev Ye.L.

1:00-2:00 p.m. Luncheon break.

2:00-6:00 p.m. Trip to the Morozov Creek, work of weir, precipitator gage network, snow gage lines, gradient observations.
Reports by Korekovtsev A.S., Ipatyeva A.I.

7:00-10:00 p.m. Dinner, Free time.

August 14 (Saturday)

8:30-9:00 a.m. Breakfast.
9:00 a.m. - 1:00 p.m. Visit to the water capacity gage No.2, water-from-soil evaporation site No.7. Observations and data collecting.
Report by Yev.L. Boyarintsev.

1:00-2:00 p.m. Luncheon.

2:00-6:00 p.m. Field trip to the Morozov Creek watershed. Experiment on evaluation of evaporation changes with elevation conducted by A.S. Korekovtsev.

7:00-8:00 p.m. Dinner.

8:00-10:00 p.m. Recreation activities.

August 15 (Sunday to Monday)

8:30-9:00 a.m. Breakfast.

Re-scheduled to Friday, 13 August

10:00 a.m. Trip by the Kulu--Ayan-Yuryakh motorroad to become acquainted with the Upper Kolyma region. Rest in the vicinity of the Ayan-Yuryakh River.

August 16 (Monday) ~~17 (Tuesday)~~

8:30-9:00 a.m. Breakfast.

9:00 a.m. -1:00 p.m. Methods employed while calculating annual and seasonal water balances for the Severny and Morozov gage sites.
Report by A.S. Korekovtsev.

1:00-2:00 p.m. Luncheon.

2:00-6:00 p.m. Effective calculations and compilations of annual and seasonal water balances for the Severny and Morozov gage sites.
Conducted by A.S. Korekovtsev.

7:00-8:00 p.m. Dinner.

8:00-10:00 p.m. Cultural and sporting activities.

August 18 (Wednesday)

8:30-9:00 a.m. Breakfast.

9:00 a.m. - 1:00 p.m. Exchange of opinions on water balance in mountainous-taiga areas with permafrost occurences.

Re-scheduled to Saturday, 14 August

Reports by A.S. Kuznetsov, Charles Slaughter, Mike Bilello. The discussion is attended by G.V. Rumyantsev.

1:00-2:00 p.m. Luncheon break.

2:00-6:00 p.m. Water balance researches in Alaska. Reported by Charles Slaughter and Mike Bibello. The principal attendants are G.V. Rumyantsev, A.S. Kuznetsov, A.I. Ipatyeva, Yu.A. Boitsov, A.S. Korekovtsev, V.N. Dovbysh, Ye.L. Boyarintsev, L.I. Boyarintseva, Ye.I. Sushchansky, V.Ye. Glotov, Yu.B. Korolyov.

Re-scheduled to Saturday, 14 August

7:00-8:00 p.m. *Dinner.*

8:00-10:00 p.m. Recreation program.

August 19 (Thursday)

8:30-9:00 a.m. Breakfast.

9:00 a.m. -1:00 p.m. Assessment of results and achievements during the Soviet-American team work at the Kolyma Water Balance Research Station.

1:00-2:00 p.m. Luncheon.

3:00 p.m. Flight to the airport of Magadan.

6:15 p.m. Leave for Khabarovsk.

Re-scheduled to Tuesday, 17 August

P R O P O S A L S

for perspectives of cooperation between the Soviet and American hydrologic specialists in the field of Northern environmental protection.

Natural waters are a unique kind of the Earth resources that make possible life and activities of man, and development of the entire humane society is unthinkable without them.

To provide population and various economic branches with fresh water is a pressing problem for an increasing number of countries. It is equally important for the northern regions both in the U.S.S.R. and the U.S.A. It is in these frontier areas that careful policy of water resources management must be carried out, since reproductive processes are very slow there. Disturbance of harmonic natural relationships may lead to uncurable outcomes. That neccessitates water balance researches to be carried out in the high north, i.e. cooperative studies of inflow, outflow, and accumulative parts of water balance system.

It seems advisable to apply cooperative efforts of the Soviet and American hydrologists in two directions:
The first one deals with different aspects of separate elements of water balance investigation, i.e.
- runoff assessment, including the processes of overland runoff formation
- investigation of evaporation processes from various underlying surfaces
- quantitative assessment of condensation
- development and testing of methods for moisture deposits

assessment in soils in order to determine their part in water balance
- determination of quatitative relations between surficial and subterraneous waters.

The second one deals with investigation of influence exerted by industrial and economic activities on separate water balance elements; specifically, mining work effects on river regime.

Hydrologists of the Kolyma Survey of Hydrometeorologic Service meet serious difficulties while studying evaporation processes from various underlying surfaces, elaborating methods of condensation quantitative assessment, and also methods of moisture deposits assessment in soils in order to determine their part in water balance. During the American delegation's staying in the Magadan Region it is hoped to gather information on the present state of investigations of the mentioned items in similar climatic conditions of Alaska with the aim of utilisation of the research results obtained by the U.S. scientists in practical service of the national industrial enterprises in this region.

In future these problems as well as construction and putting into operation instruments for their study, are subsequently to become one of the sources of the extremely important hydrologic data for this region.

Head of the Kolyma Survey of the Hydrometeorologic Service

G.V. Rumyantsev

APPENDIX B: Roster of Permanent Staff,

Kolyma Water Balance Station

(in Russian and English)

Ш Т А Т Н О Е Р А С П И С А Н И Е К В Б С

I. Довбыш Владимир	начальник станции
2. Бояринцев Евгений	старший инженер
3. Бояринцева Людмила	инженер
4. Сущанский Сергей	инженер
5. Третьякова Любовь	старший техник
6. Михайлов Владислав	старший техник
7. Косарынцева Александра	техник
8. Пузанова Галина	техник
9. Музычук Ирина	техник
I0. Радевич Ирина	техник
II. Лазук Николай	техник
I2. Пак Светлана	техник

М Е Т Е О Г Р У П П А

I3. Широбокова Надежда	старший техник
I4. Широбоков Юрий	младший техник
I5. Булакина Галина	техник
I6. Довбыш Раиса	младший техник

ROSTER OF PERMANENT STAFF, K.W.B.S.

1.	Dovbysh, Vladimir	Head of the Station
2.	Boyarintsev, Evgeny	Chief Engineer
3.	Boyarintseva, Lyudmila	Engineer
4.	Sushchavsky, Sergey	Engineer
5.	Tretyakova, Lyubov	Chief Technician
6.	Mikhailov, Vladislav	Chief Technician
7.	Kosaryntseva, Alexandra	Technician
8.	Puzanova Galina	Technician
9.	Muzychuk, Irina	Technician
10.	Radyevich, Irina	Technician
11.	Lazuk, Nikolai	Technician
12.	Pak, Svetlana	Technician

Meteorology Group

13.	Shirobokova, Nadezhda	Chief Technician
14.	Shirobokov, Yuri	Junior Technician
15.	Bulakina, Galina	Technician
16.	Dovbysh, Raisa	Junior Technician

APPENDIX C: Selected Snowpack Data, Kolyma Water Balance Station

MAXIMUM SNOW DEPTHS (cm)* OBSERVED IN THE KOLYMA WATER BALANCE STATION

Year	Snow Measurement Line	Basin Names				
		Vstrecha	Severny	Yuzhny	Sredny	Morosov
1970	I			39	33	
	II			36	46	
	III			54	46	
	IV			57	28	
1971	I		52		34	42
	II		30		48	60
	III		31		48	60
	IV		28		22	
	V		15			
1972	I	56	50	56	55	89
	II	54	48	58	49	49
	III	58	49	67	58	57
	IV	51	46	64	30	61
	V	61	23			57
	VI	39				
1973	I	63	50	41	54	76
	II	58	55	45	49	37
	III	51	53		74	45
	IV	42	37		37	41
	V	51				51
	VI	17				
1974	I	79	77	76	70	109
	II	81	81	69	77	82
	III	79	59	85	75	83
	IV	70	66	81	44	85
	V	81				74
	VI	73				
1975	I	59	56	53	58	60
	II	59	48	58	36	35
	III	57	44	56	59	54
	IV	47	53	63	31	64
	V	57				46
	VI	27				
1976	I	53	44	48	45	46
	II	55	50	42	37	55
	III	45	48	51	55	55
	IV	44	39	39	21	59
	V	49				44
	VI	27				

* Values shown are averages of a number of snow depth measurements taken:
  a) Across the numbered lines in each basin (see Fig. 11) and
  b) In April at the approximate time of maximum snow accumulation during each year.

APPENDIX D: Proposals for Future Cooperative Work
(in Russian and English)

П Р Е Д Л О Ж Е Н И Я

по сотрудничеству советских и американских специалистов-гидрометеорологов в области охраны окружающей среды северных районов

Проблема обеспечения населения и различных отраслей хозяйства пресной водой становится в наше время актуальной для все большего числа государств земного шара. Чрезвычайно важна она и для северных районов СССР и США. Именно в этих районах необходимо бережное отношение к естественным водным ресурсам, так как восстановительные процессы происходят здесь весьма медленно. Нарушение естественной природной гармонии может привести к непоправимым последствиям. Вот почему необходимы комплексные гидрометеорологические исследования северных территорий, т.е. совместное изучение приходной, расходной и аккумулирующей части водного баланса.

В связи с этим стороны считают целесообразным производить обмен материалами наблюдений и результатами исследований в районах распространения многолетней мерзлоты, выполняемых на Колымской воднобалансовой станции Колымского управления гидрометслужбы и в исследовательском бассейне Карибу-Покер-Крик в центральной части Аляски, где ведут исследования Институт северного лесного хозяйства, Аляскинский университет и др.

Сотрудничество советских и американских специалистов-гидрометеорологов должно проводиться по двум направлениям. Первое - по вопросам исследования отдельных элементов водного баланса:

- учету жидких и твердых осадков в горно-таежных условиях;
- характеру залегания и распределения снежного покрова ;
- изучению физико-механических свойств снега;
- учета стока, в том числе изучение склонового стока;
- изучения испарения с различных видов подстилающей поверхности;
- количественной оценки конденсации;
- разработке и испытания методов учета влагозапасов в почве;
- установления количественной связи поверхностных и подземных вод.

Второе - по изучению влияния хозяйственной деятельности на изменение элементов водного баланса.

На первом этапе сотрудничества стороны считают необходимым систематически обмениваться методами исследований и приборами при гидрометеорологических работах в бассейнах КВБС и Карибу-Покер-Крик, а именно:

- ежегодными результатами наблюдений, а также по мере их публикации:

- методическими указаниями, инструкциями и наставлениями по производству гидрометеорологических работ и исследований, проводимых в указанных бассейнах;

- приборами и оборудованием, применяемыми при гидрометеорологических наблюдениях и исследованиях, в том числе приборами и оборудованием по изучению физических свойств снега, применяемых в КРРЕЛ (лаборатория по изучению холодных районов и инженерно-строительных работ армии США);

- научными обобщениями по материалам исследований, проводимых в указанных бассейнах (статьи, монографии, сборники работ и др.).

- В целях расширения долгосрочного сотрудничества (1977-1980 гг.) между Колымским УГМС и соответствующими организациями, занимающимися изучением внешней среды на Аляске, стороны считают необходимым внести следующие предложения в Смешанную советско-американскую комиссию по сотрудничеству в области охраны внешней среды:

- по объединению усилий советских и американских гидрометеорологов северных районов на изучение испарения с различных видов подстилающей поверхности, для чего разработать в 1976 г. приемлемую программу совместных исследований;

- по прямому обмену специалистами-гидрометеорологами;

- по дальнейшему обмену результатами исследований, приборами, оборудованием и др.;

- по изучению возможности обмена гидрометеорологической (климатологической и гидрологической) информацией по территории Магаданской области и Аляски;

- по изучению влияния хозяйственной деятельности на изменение отдельных элементов водного баланса. Например, изучение влияния горных работ на режим рек в конкретных бассейнах Магаданской области и Аляски.

Предложения подготовлены в результате обмена мнениями между советскими (Г.В. Румянцев, А.С. Кузнецов, А.И. Ипатьева, А.С. Корековцев, В.Н. Довбыш, Е.Л. Бояринцев, Ю.А. Бойцов, В.Г. Глотов) и американскими (Ч.У. Слотер и М.А.Билелло) специалистами в период с 5 по 17 августа 1976 г., которые посетили Колымскую воднобалансовую станцию в соответствии с Меморандумом IУ сессии Смешаной советско-американской комиссии по сотрудничеству в области охраны окружающей среды.

Данные предложения могут дополняться и изменяться обеими сторонами по мере накопления новых материалов наблюдений и постановки новых вопросов.

Во время настоящего визита американских специалистов и подготовки совместных предложений перевод выполнял Ю. Стома.

Настоящее соглашение подписали:

Начальник Колымского УГМС

Г.В. Румянцев

Ч.У. Слотер

Главный гидролог Института северного лесного хозяйства, Лесная служба США, Фэрбенкс, Аляска, США, 99701

Директор Магаданской гидрометобсерватории

А.С. Кузнецов

Магадан, Парковая 7/13, 685000

М.А. Билелло

Метеоролог, КРРЕЛ США, Ганновер, Нью-Хэмпшир, США, 03755

Колымская воднобалансовая станция

16 августа 1976 г.

PROPOSALS

On Cooperation Between Soviet and American Hydrometeorology Specialists in the Field of Northern Environmental Protection

The provision of people and various economic enterprises with fresh water is a pressing problem for an increasing number of countries. It is equally important for the northern regions of both the U.S.S.R. and the U.S.A. It is in these frontier areas that careful resources management must be carried out, since environmental recovery processes are very slow there. Disturbance of harmonious natural relationships may lead to irreversible changes. This necessitates interdisciplinary hydrometeorological research to be carried out in the high north, i.e., cooperative studies of inflow, outflow and storage parts of the water system.

In this regard, both sides consider it reasonable to carry out exchange of observational materials and results of investigations for areas of permafrost occurrence conducted at the Kolyma Water Balance Station by the Kolyma Hydrometeorologic Survey and at the Caribou-Poker Creeks Research Watershed, central Alaska, by the Institute of Northern Forestry, the University of Alaska, etc.

Cooperation between Soviet and American specialists in hydrometeorology should be undertaken in two directions. The first deals with investigations of separate elements of the water balance:

1) Assessment of liquid and solid precipitation in mountainous and taiga conditions

2) Characteristics of occurrence and distribution of snowpacks

3) Investigation of physical and mechanical properties of snow

4) Runoff assessment, including slope runoff formation

5) Investigation of evaporation from underlying surfaces

6) Quantitative assessment of condensation

7) Development and testing of methods for moisture content assessment in soils

8) Determination of quantitative relations between surface and ground water resources

The second one deals with investigation of the influence exerted by industrial and ecomonic activities on separate water balance elements.

At the first stage of cooperation, the two sides consider it necessary to conduct systematic exchange of research methods and instruments used during hydrometeorologic programs at the basins of the KWBS and the Caribou-Poker Creeks as follows:

1) Observational results on an annual basis or as otherwise available

2) Methodological instructions for hydrometeorological programs and investigations undertaken at the mentioned research basins

3) Instruments and equipment used during hydrometeorological observations and investigations, including instruments and equipment for study of physical properties of snow used by CRREL (Cold Regions Research and Engineering Laboratory)

4) Scientific summaries of research materials obtained at the mentioned basins (Papers, monographs, collections, etc.)

Toward the objectives of long-term cooperation (1977-1980) between the Kolyma Hydrometeorological Service and appropriate counterpart organizations engaged in environmental research in Alaska, the two sides consider it necessary to submit proposals to the U.S.-U.S.S.R. Joint Committee on Cooperation in the Field of Environmental Protection as follows:

1) To integrate efforts applied by the Soviet and American hydrometeorologists in northern regions to the study of evaporation from various underlying surfaces and towards this end to develop a mutually acceptable program of joint investigation

2) To implement direct exchange of specialists in hydrometeorology

3) To carry out further exchange of observation results, instruments, equipment, etc.

4) To study the possibility of exchange of hydrometeorologic (climatic and hydrologic) data for Magadan Oblast and Alaska

5) To study influences exerted by industrial and economic activities on individual elements of the water balance, for example, the effects of mining activities on river regime in specific basins of Magadan Oblast and Alaska

The foregoing porposals have been prepared as the result of exchange of opinions between the Soviet (G.V. Rumyantsev, A.S. Kuznetsov, A.I. Ipatyeva, A.S. Korekovtsev, V.N. Dovbysh, Ye L. Boyarintsev, Yu. A. Boitsov, V. Ye. Glotov) and American (C.W. Slaughter and M.A. Bilello) specialists during the period 5-17 August 1976, while visiting the Kolyma Water Balance Station in accordance with the Memorandum of the Fourth Meeting of the Soviet-American Joint Committee on Cooperation in the Field of Environmental Protection.

These proposals are subject to additions and amendments by both sides as new observational materials appear and new problems are set forth.

During this visit of the U.S. specialists and preparation of these joint proposals, translation works were carried out by Yu. A. Stoma.

This agreement was signed by:

Head of the Kolyma
HMS
G.V. Rumyantsev

C.W. Slaughter

Principal Watershed Scientist
Institute of Northern Forestry
U.S. Forest Service
Fairbanks, Alaska 99701

Director of Magadan
Hydrometeorological Observatory
A.S. Kuznetsov

M.A. Bilello

Meteorologist
USA CRREL
Hanover, New Hampshire, USA 03755

Magadan, 68500
Parkovaya St., 7/13

Kolyma Water Balance
Station

16 August 1976

APPENDIX E: *Pravda* article Concerning Exchange Visit, with English translation

● Магаданские гидрологи принимают американских специалистов ● Экспе-

ЕЛЕВИЗОР-
АЛЮТКА

...ТАТИВНЫЙ пере-
...жный микротелевизор
...роника-601» с разме-
...ображения по диаго-
... сантиметров и ве-
... килограмм. Он создан
...листами витебского
...оизводственно - техничес-
... объединения «Моно-
Телевизор выполнен
...гральных схемах и
...значается для приема
...левых передач на 12
... Питается аппарат
... сети переменного
...так и любого источни-
...оянного тока, что по-
... использовать его
... автомобиле. Микро-
...зор имеет собствен-
...кладную телескопи-
... антенну.

... А. Церлюкевича.
Фотохроника ТАСС.

НАШИ ИНТЕРВЬЮ

ВСТРЕЧА КОЛЛЕГ

В СООТВЕТСТВИИ с договором между СССР и США о сотрудничестве в области охраны окружающей среды Колымское управление гидрометеослужбы принимает двух американских специалистов -гидрологов. В течение двух недель гости будут знакомиться с работой Колымской воднобалансовой станции.

Мы попросили директора Магаданской гидрометеорологической обсерватории А. С. Кузнецова рассказать о цели посещения американскими специалистами воднобалансовой станции, чем вызван этот интерес и о возможностях сотрудничество магаданских и американских гидрологов.

„ИНОСТРАННЫХ специалистов, — сказал А. С. Кузнецов, — мы принимаем впервые. Интерес американских гидрологов к нашей станции появился после ряда посещений Магадана учеными-биологами этой страны по приглашению института биологических проблем Севера. На базе нашей станции работает стационар этого академического учреждения.

Понятно, что охрана окружающей среды требует комплексного подхода. Отсюда участие гидрологов в изучении проблемы охраны экологических систем в северных районах.

Мы познакомим американских коллег с гидрологическими исследованиями коллектива Колымской воднобалансовой станции.

Станция расположена в Тенькинском районе, в 16 километрах от поселка Кулу. Она существует уже 28 лет, сейчас в ее штате более двадцати сотрудников. Работа ведется на территории 21,2 квадратных километра. Здесь имеются все существующие виды установок по изучению стока малых рек. Только осадки регистрируют более 50 приборов.

Станция работает в своеобразном горном районе с распространением многолетней мерзлоты. Здесь изучаются все элементы водного баланса — осадки, сток, испарение, конденсация, запас влаги в почвогрунтах и другие. То есть исследуются одновременно приходная и расходная части водного баланса, отсюда ее название «воднобалансовая».

Опыт многолетних исследований показал, что выводы, полученные по материалам наблюдений, характерны для бассейна всей верхней Колымы — наиболее промышленно развитого и населенного района.

Это благодатная природная лаборатория для гидрологических исследований. На ее небольшой территории наблюдения ведутся в бассейнах, расположенных на разной высоте (в долине и среднегорье), с различной подстилающей поверхностью, с богатым выбором экспозиции склонов.

Комплексное изучение всех элементов водного баланса на таком «пятачке» позволяет сделать определенные выводы относительно его формирования. Выявленные закономерности можно перенести на промышленные, сельскохозяйственные районы и использовать материалы при решении вопросов водоснабжения, рационального использования водных ресурсов, совершенствования методов прогноза дождевых паводков. Это особо важно для тех бассейнов, где ведутся интенсивные горные работы (Тенька, Омчак, Дебин, Сусуман, Берелех и другие).

Думается, американских ученых этот район заинтересует тем, что водный баланс изучается здесь и в малом бассейне, целиком сложенном каменными осыпями. Здесь своеобразно формируется сток (весьма высокий). Насколько нам известно, в США такие исследования не ведутся.

Как и для нашего Северо-Востока, для соседней с ним Аляски характерны дождевые паводки. Американские гидрологи ищут «противоядие» от их разрушительной силы. Поэтому нашим гостям будет полезно изучить наш опыт.

Что бы мы могли позаимствовать из практики работы американских специалистов? При изучении элементов водного баланса в условиях вечной мерзлоты мы встречаемся с рядом трудностей. Сложности возникают при определении испарения, конденсации, запасов влаги в почвогрунтах и других составляющих. На станции ставятся эксперименты. Надеемся на совет в этом наших гостей. Возможно, у них есть интересующие нас приборы.

Несомненно, такой обмен знаниями будет полезен для обеих сторон, послужит лучшей постановке гидрометеорологической службы в благородных целях охраны окружающей среды, укреплению научных и дружественных связей советских и американских специалистов».

ЛЮДИ СКРОМНЫХ ПРОФЕССИЙ

ПОВАР ПЕРВОЙ РУКИ

УСТЬ-СРЕДНЕКАНСКАЯ столовой. Они всегда остаются новедь в нашей работе — быть

9 АВГУСТ...

ПЕРВАЯ ПРОГ...

ВТОРАЯ ПРОГ...

U.S.S.R.-U.S. COOPERATION IN ENVIRONMENTAL PROTECTION

Magadan MAGADANSKAYA PRAVDA in Russian 8 Aug 76 p 4

(Interview with A.S. Kuznetsov, director of the Magadan Hydrometeorological Observatory: "A Meeting of Colleagues")

(Text) In conformance with the U.S.S.R.-U.S. agreement on cooperation in the field of environmental protection, the Kolyma hydrometeorological service administration is receiving two American hydrological specialists. They will spend 2 weeks familiarizing themselves with the work of the Kolyma water-balancing station.

We asked A.S. Kuznetsov, the director of the Magadan Hydrometeorological Observatory, to describe the purpose of the visit of the American specialists to the water-balancing station, to tell what prompted the interest in this matter, and to discuss the possibilities for cooperation between the Magadan and American hydrologists.

"We are receiving the foreign specialists for the first time," said A.S. Kuznetsov. "The American hydrologists became interested in our station after a number of visits to Magadan by biologists of that country on the invitation of the Institute of Biological Problems of the North. A laboratory of this academic institution is in operation at the base of our station.

Of course, environmental protection requires a comprehensive approach. Hence the participation of hydrologists in study of the problem of protection of the ecological systems in the northern regions.

We are apprising our American colleagues of the hydrological research done by the collective of the Kolyma water-balancing station.

The station is located in Ten'kinskiy Rayon, 16 kilometers from Kulu settlement. It has now been in existence for 28 years and its staff comprises more than 20 associates. Its work is conducted over an area of 21.2 square kilometers. On hand are all the existing types of installations for study of the discharge of small rivers. More than 50 instruments are employed just for registering the precipitation.

The station operates in an unusual mountain region with widespread frozen ground developed over a period of many years. The study being carried out here covers all the elements of the water balance--precipitation, drainage,

evaporation, condensation, moisture reserve in the soils, and other subjects. That is, the study includes at the same time the incoming and outgoing parts of the water balance and hence its name "water balancing."

Many years of research have shown that the conclusions drawn from the observation materials are relevant for the basin of the entire upper Kolyma--the most industrially developed and the most populous region.

This region is a richly endowed natural laboratory for hydrological research. On this small territory observations are being made in basins located at various altitudes (in the valley and on the mountain) with a diversity of surface and a rich selection of slopes on display.

A comprehensive study of all the elements of the water balance in this kind of "quintet" enables us to draw definite conclusions regarding its formation. The objective laws brought to light can be carried over to industrial and agricultural regions and the materials can be used in resolving problems connected with water supply, rational use of the water resources and improvement of the methods of forecasting rain flooding. This is especially important for the basins where intensive mining work is in progress (Ten'ka, Omchak, Debin, Susuman, Berelekh and others).

The American scientists are apparently interested in this region because the water balance here is also being studied in the small basin which was formed wholly from waste rocks. An unusual discharge has developed here (an extremely high one). To the best of our knowledge, no such research is being done in the U.S.

Both our northeast and the adjacent Alaska are characterized by rain flooding. The American hydrologists are searching for an "antidote" for the destructive force of the floods. Out guests will therefore find it useful to study our experience.

What can we borrow from the work experience of the American specialists? In studying the elements of the water balance under the conditions of perpetually frozen ground we encounter a number of difficulties. Complications arise in the process of determining evaporation, condensation, moisture reserves in the soils, and other factors. Experiments are being set up at the station. We hope to get advice from our guests in this matter. Perhaps they have instruments which will be of interest to us.

This kind of exchange of knowledge will undoubtedly be useful for both sides and will serve to enhance the performance of hydrometeorological service for the desirable purpose of protection of the environment and strengthening of the scientific and friendly relations between the Soviet and American specialists."

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APPENDIX F: Caribou-Poker Creeks Research Watershed Synopsis

BASIN	CARIBOU-POKER CREEKS RESEARCH WATERSHED, ALASKA- representative and experimental	
ORGANIZATION IN CHARGE OF ACTIVITY	Inter-agency Technical Committee for Alaska	
	Primary Contact:	Institute of Northern Forestry, U.S. Forest Service, Fairbanks, Alaska 99701
	Cooperating Agencies:	National Weather Service (NOAA) Cold Regions Research and Engineering Laboratory (USA CRREL) Arctic Environmental Research Station (EPA) University of Alaska Soil Conservation Service (USDA) Geological Survey (USDI) Division of Lands (State of Alaska) Bureau of Land Management (USDI) Corps of Engineers (U.S. Army)
PHYSIOGRAPHIC PROVINCE:	Yukon-Tanana Uplands of the Northern Plateaus Province, Central Alaska	
PHYSIOGRAPHIC DESCRIPTION OF REGION	Geology:	Pre-cambrian Birch Creek Schist
	Topography:	Mountainous
	Soil:	Aeolian silts over shattered schists
	Vegetation:	Fire-patterned black spruce/birch/ aspen/white spruce/mosaic, with dense moss/lichen/forb understory
	Climate:	Subarctic, continental
LOCATION OF BASIN	Area:	40.8 mi^2 (105.6 km^2)
	Longitude:	147°30'W
	Latitude:	65°10'N
	Elevation:	700 ft to 2760 ft MSL (213 m to 826 m MSL)
	Median Altitude:	1600 ft (487 m)

PHYSIOGRAPHIC DESCRIPTION OF BASIN	Geology:	Unglaciated, pre-cambrian Birch Creek schists
	Topography:	Rounded, steep-sided ridges, V-shaped and narrow headwaters valleys
	Soils:	Shallow silts and silt loams, developed in aeolian deposits over shattered schists; poorly drained and underlain by permafrost on north slopes and valley floors; free from permafrost on south slopes
	Vegetation:	Black spruce/larch/alder with thick moss, lichen, forb/shrub understory on north slopes; aspen/birch/alder complex on south slopes with isolated stands of mature white spruce, small sections of alpine tundra; valley floors dominated by poorly drained, riparian community of willows, dwarf birch, cottongrass, and blueberry
	Climate:	Subarctic, Continental, with short, warm summers and long, cold winters
EQUIPMENT	Two permanent stream-gauging stations (USGS) with natural controls; recording precipitation, temperature (air, ground, stream) network; telemetering precipitation, wind recorders, through repeater to Fairbanks base; snow pillow, three SCS snow courses; two field lab trailers installed in basin; first instrumentation installed 1969.	
OBJECTIVES	To evaluate for permafrost-dominated catchments and catchments free from permafrost, (1) Hydrometeorological regimen, precipitation/streamflow relationships in subarctic uplands (in representative basin), and (2) hydrologic and environmental response of subarctic uplands to landscape manipulations and forest management practices.	
HISTORY AND PRESENT WORK	Present basin established and hydrometeorological measurements initiated in 1969; data summaries published annually; geologic, soils, vegetation maps completed; reconnaissance water quality reports completed; hydrologic analyses currently underway.	

PROPOSED DEVELOPMENTS

Improved areal distribution of precipitation network; upgrade streamflow measurement network to discriminate among headwaters tributary streams; increase attention to snowmelt/aufeis/streamflow interrelations at spring breakup; initiate landscape manipulation treatments (following appropriate calibration) in experimental basin.

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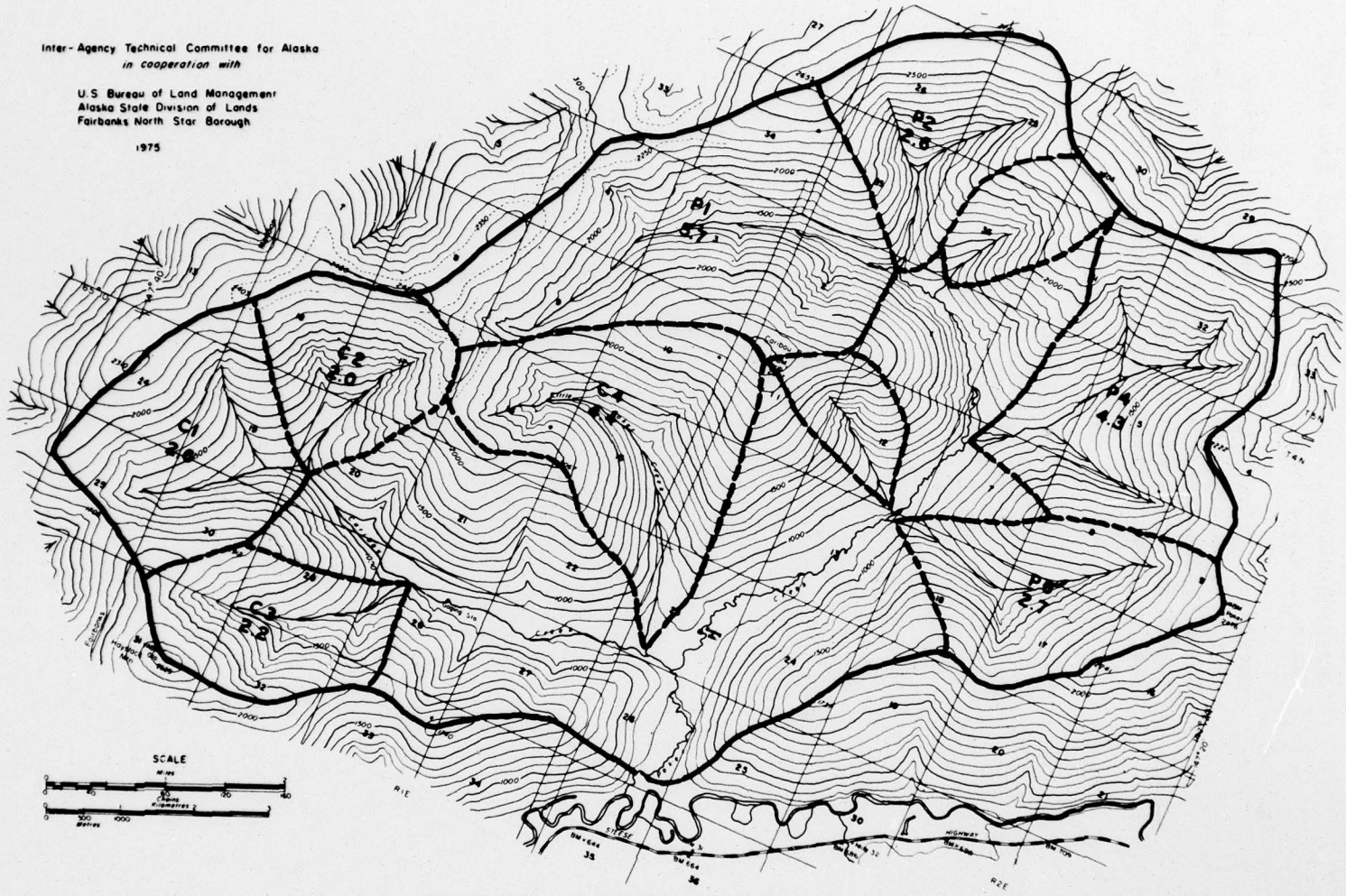

CARIBOU-POKER CREEKS RESEARCH WATERSHED